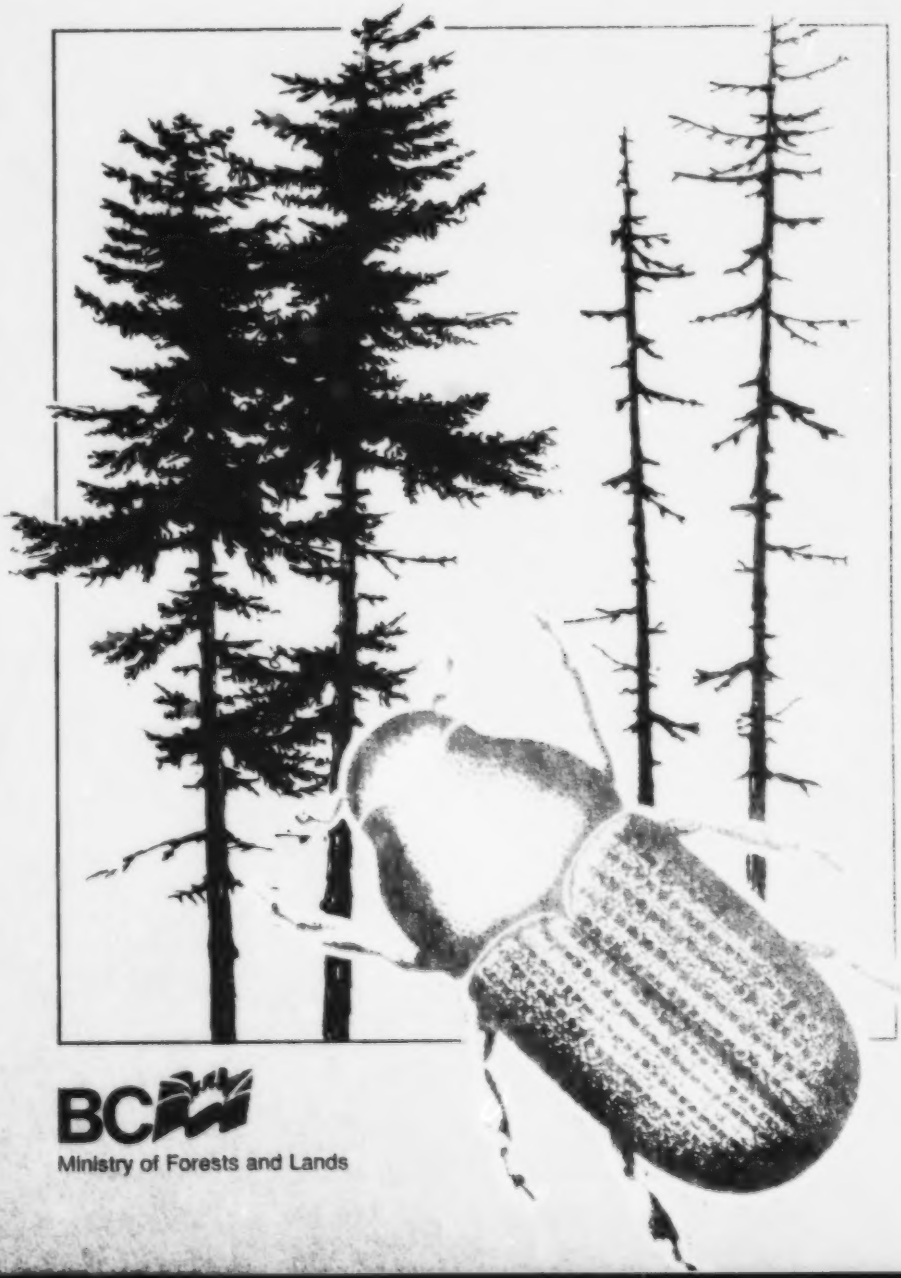

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BARK BEETLES –

A THREAT TO OUR FORESTS

BC
Ministry of Forests and Lands

Extensive areas of forests killed by bark beetles pose significant problems to forest management.

Bark Beetles – A Threat to our Forests

Why the Concern?

Because Bark Beetles Destroy Large amounts of our Most Important Natural Resource . . . Forests

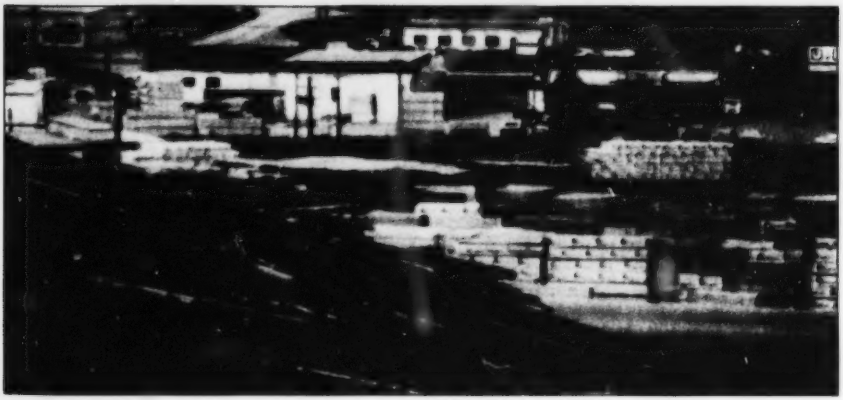
Most organisms, trees included, are prey to a variety of agents which can cause sickness or death. Coniferous trees such as pine, spruce and Douglas-fir, are all susceptible to attack by insects and diseases, resulting in damage which ranges from growth loss to tree deformity to death. Protection of trees from pests is an important aspect of forest management in British Columbia.

Forestry is British Columbia's largest industry, employing some 90,000 people. Production of plywood, lumber, pulp and paper and other wood products provides economic stability for many communities throughout the province. The annual harvest totals about 75 million cubic metres, enough wood to construct over three million average homes. This yearly cut is determined partly on the basis of how much wood is grown each year. The level will be maintained through silvicultural prescriptions and through comprehensive efforts in protection.

Large, unexpected insect outbreaks which kill extensive areas of mature, commercially valuable timber disrupt calculations of cutting levels.

The premature death of large numbers of trees greatly reduces the productivity of the forest and upsets long-term management plans. Such disruptions have an adverse effect on many communities as timber for their mills becomes unavailable or too expensive to harvest. Other resource values such as watersheds, wildlife and aesthetics can be negatively affected by extensive outbreaks of tree-killing insects. Many of these losses can be minimized or "saved" through the application of good forest management strategies at the appropriate time in the life of the forest.

Many B.C. communities depend on forest-related industry.



Bark beetles – a native insect . . . a major problem

Bark beetles are among the most dangerous forest insect pests. They can kill huge numbers of mature pine, spruce and other tree species and represent one of the most pressing problems facing forest management today.

Bark beetles are native to the forests of British Columbia. As well as being a threat, they serve a natural function in the life-cycle of a forest, helping to remove weakened or old trees, aiding in the natural process of forest renewal. All major species of bark beetles have a similar appearance.

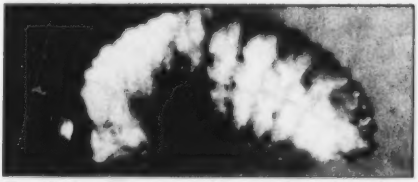
The public is advised of hazards due to bark beetles in some areas.

- **The adults** are hard, stout-bodied cylindrical insects, ranging in length from 3.5 mm to 6.5 mm. They usually have black heads and brownish bodies, and bore under the bark of trees to lay their eggs in long galleries in the phloem, that area between the outer bark and the wood.

An adult bark beetle - about 5 mm long.

- **The larvae** hatch from the eggs and begin feeding on the tree tissues of the phloem and cambium. Trees are killed when completely encircled by the larvae, cutting off the flow of food and water to the roots and leaves.

Adults excavate galleries under the bark in which they lay their eggs.



Beetle larvae, or grubs, are found under the bark of infested trees. They grow up to about 5 mm long.

After passing through a total of four stages – or instars – the larvae pupate and eventually mature into new adults, ready to fly and infest new trees.

To further complicate matters, the adult bark beetles also carry spores of a blue-staining fungus, a problem unto itself because it colonizes the sapwood of infested trees, further cutting off their nutritive pathways. The fungus also serves to protect the feeding beetle adults and larvae by preventing the trees from exuding pitch which can kill them.

The several species of bark beetles in British Columbia each attack a specific species of conifer:

Blue staining fungus, introduced by the burrowing beetles, blocks off water-conducting tissues in the tree.

Beetle Species	Tree Species Attacked
A. Prime Importance	
Mountain pine beetle	Lodgepole pine, Ponderosa pine
Spruce beetle	Englemann/white spruce
Douglas-fir beetle	Douglas-fir
B. Lesser Importance	
Balsam bark beetle	True firs (e.g., subalpine fir)
Western pine beetle	Ponderosa pine

• Mountain Pine Beetles

These beetles primarily attack living, older, large-diameter pine trees. Many beetles infest a single tree, kill it and raise a new generation of beetles which emerge to attack and kill more standing trees. Outbreaks of mountain pine beetle initially occur in less healthy, over-mature stands, and as more and more trees are infested, the beetle population quickly increases and spreads. As outbreaks continue to expand, healthy trees are killed and huge areas of mature pine stands may be killed or threatened. Warm summers and mild winters are advantageous to the insect and play a major role in insect survival and continuation of an outbreak. Adverse weather conditions can reduce the beetle populations and slow the spread, but the insects can recover quickly and can resume their rampage.

• Spruce and Douglas-fir Beetles

These beetles normally infest downed trees or logging debris. However, when beetle populations are large they will attack and kill living trees causing wide-spread damage, especially in vulnerable, weak stands. Weather conditions again play a major role in the life cycles of these insects.

Most of the bark beetle problems in British Columbia have resulted from mountain pine and spruce beetle outbreaks.

The Extent of the Damage – Even a little is too much these days

When the first pest surveys were carried out in British Columbia in 1913, the most serious insect problems encountered were mountain pine and spruce beetles. Infestations of these insects undoubtedly occurred for years prior to this survey as a normal part of the forest cycle.

Outbreaks of these insects have been recorded at various times since surveys began. Although they were extensive, there was little impact on the forest industry until relatively recent times. Most of the industry was concentrated in coastal areas where bark beetles are not traditionally a problem. The forest resource was also considered so extensive in the past that losses due to insects and other pests were not viewed as important because of the vast dimension of the resource.

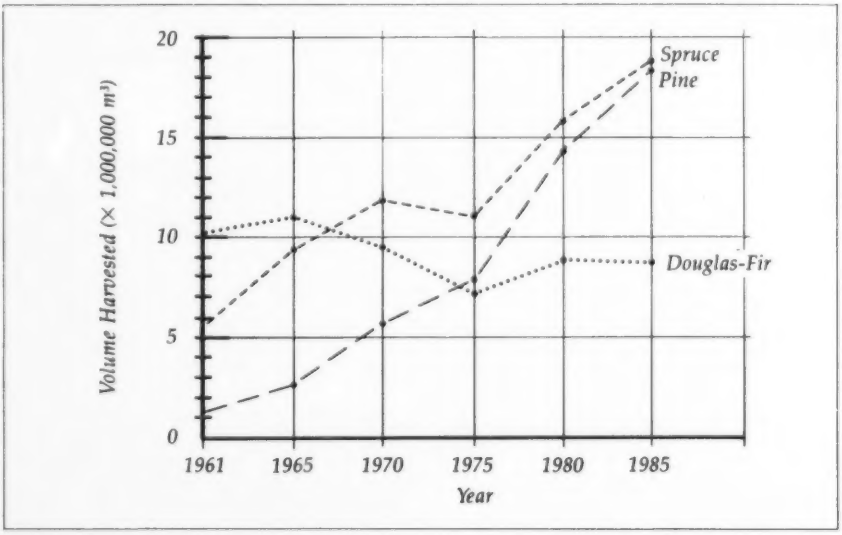
In the early days of the industry, the most commercially valuable tree species were Douglas-fir and spruce; lodgepole pine was considered to be a low value weed tree. In 1962, for instance, Douglas-fir was the leading species harvested (about 11 million m^3), spruce was third (6.8 million m^3), and pine was a distant sixth, at a little over one million m^3.

But times – and the commercial viability of the species – have dramatically changed. By 1986, spruce was number one (almost 19 million m^3) with pine a close second (more than 18 million m^3) and Douglas-fir had dropped to fifth (8.6 million m^3). This shift occurred because logging has become the largest industry in the interior of the province and lodgepole pine is now an important commercial species.

Timber supplies are not unlimited, and we can no longer afford to lose large numbers of trees.

Bark beetles have become a major concern because the trees they affect have increased so dramatically in value

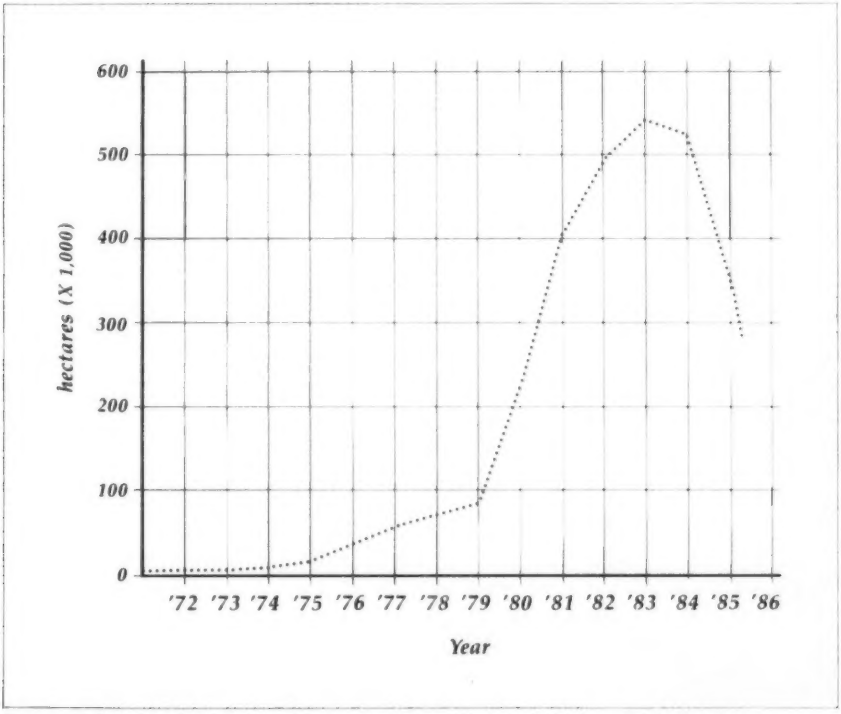
B.C. Timber Harvest by Species.



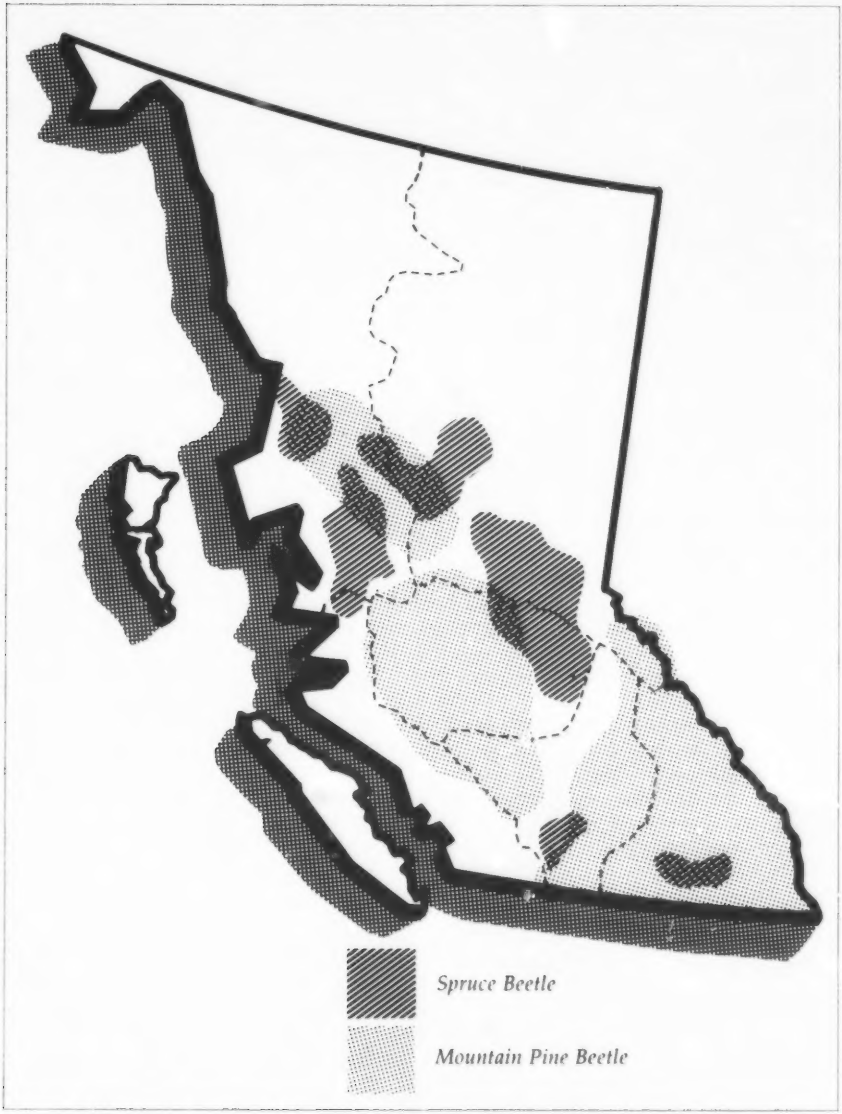
and because of the wide extent of the infestations. Further, because of effective fire suppression since the early 1900's, large continuous areas of forest have grown to an age and size that are highly susceptible to attack by bark beetles. Bark beetles pose a major threat to these areas which also represent an important segment of the forest resource.

From the Outback to the Back 40 - The unwelcome expansion of the bark beetle menace. Devastating outbreaks have innocuous beginnings. Small patches of trees killed by mountain pine beetles were detected in the early 1970's in several areas of the province such as the western Chilcotin Plateau, the Flathead Valley in southeastern British Columbia, and the interior of the Prince Rupert Region near Houston and other communities. Little was done to control these incipient outbreaks because of their remote locations, uncertainties concerning their potential for spread, and the fact that lodgepole pine had only recently been identified as a commercially desirable species.

Unfortunately, these "hot spots" rapidly expanded and coalesced, new infestations arose in susceptible stands, and large bark beetle populations moved northward into the Flathead Valley from outbreaks in Glacier National Park in the United States. By 1978, 82 000 hectares were infested by mountain pine beetle in the interior of the province. By 1983, more than 460 000 ha were under attack, with over 17,000,000 m^3 of pine killed in that year alone. By 1986, estimates of total cumulative mortality exceeded 50,000,000 m^3 – a staggering increase.



Estimated Area With Recent Mortality From Pine and Spruce Bark Beetles.

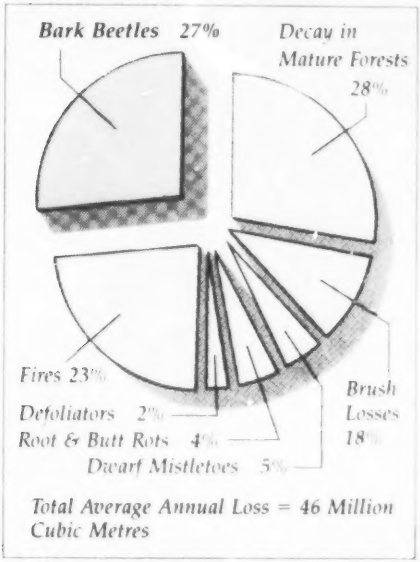


Map of Forest Regions Noting Areas Where Bark Beetle Infestations Have Occured, 1975-1986.

Infestations of spruce beetles have occurred in most forest regions as well. In 1983, the peak year of the most recent outbreak, surveys indicated that infestations covered over 65 000 ha. These insects killed a total of over 15,000,000 m^3 of spruce over the period between 1977 and 1984.

Although loss figures are difficult to obtain for Douglas-fir beetles, outbreaks have occurred several times in highly susceptible areas. Outbreaks of other insects such as Douglas-fir

tussock moth or western spruce budworm have contributed to losses from this bark beetle as defoliation weakens and allows bark beetles to kill large numbers of trees. Douglas-fir beetle outbreaks have been a sporadic problem: good logging practices and sanitation have kept infestations of this insect to a minimum at most locations.


Bark Beetles 27%
Decay in Mature Forests 28%
Fires 23%
Defoliators 2%
Root & Butt Rots 4%
Dwarf Mistletoes 5%
Brush Losses 18%
Total Average Annual Loss = 46 Million Cubic Metres

Average Annual Timber Losses in British Columbia, 1982-1986.

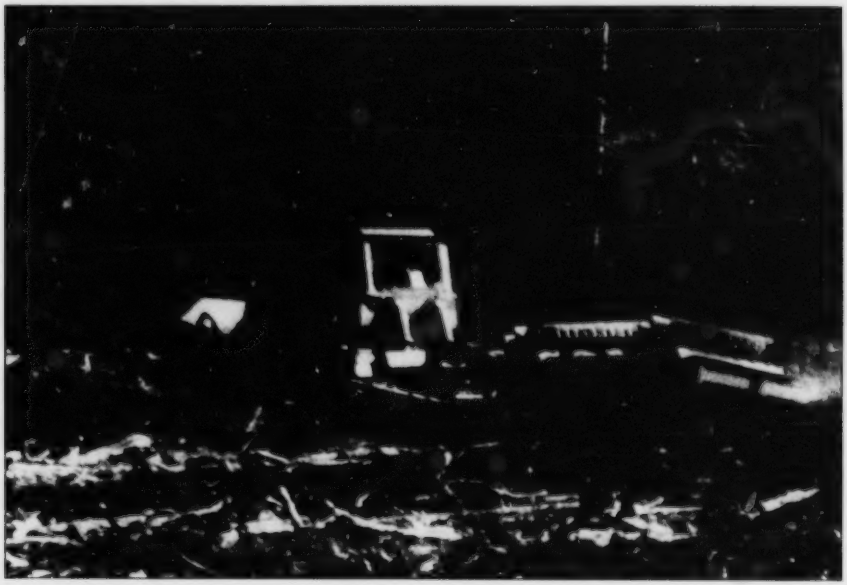
Extensive stands of highly susceptible pine and spruce still exist throughout the province and represent the major timber supplies available to many forestry dependent communities. These stands are at risk of being destroyed by mountain pine beetle and spruce beetle. Douglas-fir stands in susceptible areas will continue to be subject to chronic losses. The potential for beetle-induced losses must be acknowledged and managed for in the future. Outbreaks must be dealt with in the early stages to protect susceptible timber.

A Host of Problems Follow the Bark Beetles

The magnitude of beetle-caused losses has had a great impact on forest management, and on the management of other resources. There are impacts aside from the obvious impacts on the resource resulting from extensive areas of dead trees. Disruption of long-term planning is one of the key concerns. Normally, forest management plans are developed for five-year periods. Unforeseen bark beetle infestations disrupt these plans in a number of ways:

- Road building must be curtailed in some areas and accelerated in others, incurring increased costs.
- The amount of timber killed by beetles can exceed the amount that can be harvested; the remaining

Increased logging may be necessary in some areas to deal with beetle outbreaks.



Stands killed by beetles must be harvested or removed to return the site to productivity.

dead trees then lose their value as timber and the future resource is reduced.

- In some areas, logging must be increased over planned levels to deal with the beetles, again reducing future harvest.
- Areas logged because of beetle infestation may differ from those identified in management plans so seedlings originally ordered for replanting may not be suitable.
- Further costs include those incurred when treating large areas of dead forest so that they will again produce live, healthy trees, and when protecting extensive amounts of dead, drying timber from forest fires.

Large areas of beetle-killed forest also have a significant impact on other resource values such as watersheds, fish, wildlife, and recreation:

- Extensive killing of trees by bark beetles can remove forest cover and change water run-off patterns, disrupting water supplies to communities and affecting fisheries.
- Some species of wildlife depend upon certain types of forests for food and shelter; large areas of dead forest can reduce or change their available range.
- Recreation values in forests and parks may be reduced, along with the value of private homes, as aesthetic values decline due to areas of dead trees.

Aesthetic values in parks and other scenic recreation areas can be affected by bark beetle outbreaks.

What Can Be Done? In the long and the short-term . . . quite a bit

It is impossible to completely eliminate bark beetles from our forests, nor is it desirable. They will continue to exist and perform their function in recycling the forest; but, the damage they do to the forests can be minimized through management practices, especially in pine and spruce stands. Long-term strategies have been designed that will help to reduce the susceptibility of forests and limit the size of infestations. Short-term direct control strategies will protect some areas for a few years and delay the expansion of infestations, providing time to implement more long-term solutions.

Long-Term Management Practices

Bark beetles prefer certain types of trees in the stands they infest – larger, older trees that are more susceptible. Forests with a high percentage of these trees face a higher hazard and are more likely to experience significant beetle infestations. Large forests of susceptible trees encourage rapid expansion of infestations; smaller more isolated stands of susceptible forest will have correspondingly smaller infestations.

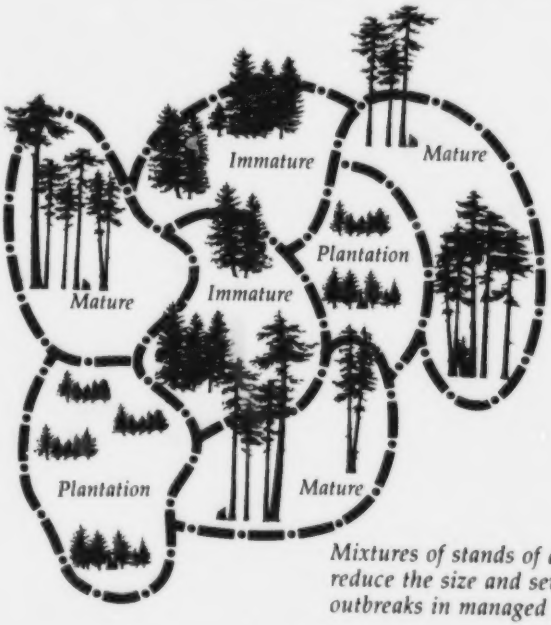
Long-term management practices aimed at reducing bark beetle losses are intended to change the nature of the forest, reducing the susceptibility of individual stands so that large areas of forest are no longer available to maintain large, ongoing infestations. The implementation of good, clean logging practices also reduces the threat of infestations – especially those of spruce and Douglas-fir beetles. Such clean logging practices remove large amounts of windthrow and logging debris – the preferred breeding grounds of these bark beetle species.

A basic requirement for long-term management is the provision of access into all management areas. This is necessary so that logging or other treatment prescriptions can be carried out when and where needed.

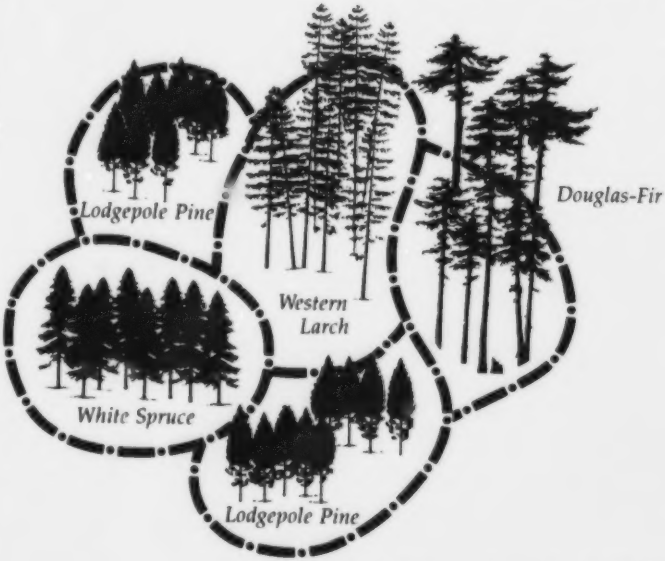
Silvicultural prescriptions will not eliminate beetle damage from our forests. They will, however, greatly reduce the levels of future damage sustained in any one outbreak. Forestry practices which will reduce future losses to bark beetles include:

- harvesting stands at a young age before they become susceptible to bark beetle attack.
- creation of age class mosaics that will reduce the number of large continuous areas of susceptible stands.
(see next page)
- creation of tree species mosaics that break the forest up into patches of different tree species, thus reducing the potential limit of spread of any infestation.
(see next page)
- encouraging stands with a mixture of species so that only a portion of a stand would be killed in an outbreak.
- removing some trees through thinning to allow more room for others may increase and prolong the health of remaining trees, making them less susceptible to bark beetles.

Implementation of these silvicultural practices, however, will not save trees from current active infestations. It is also important to have some short-term, direct control management options available to deal with present problems.



Mixtures of stands of different ages can reduce the size and severity of beetle outbreaks in managed forests.

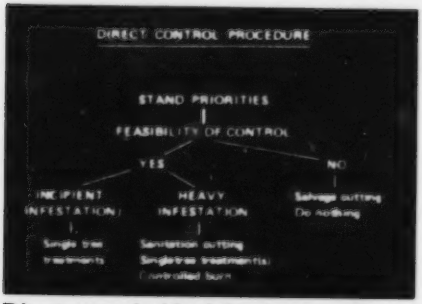


Mixtures of stands of different tree species reduce the size of stands susceptible to bark beetles.

Short-Term Direct Control Measures

Direct control or suppression of infestations will slow the rate of spread and allow greater time to implement long-term management plans. These actions will not provide a final solution to the problem of bark beetles.

Direct control requires the elimination of large numbers of beetles to reduce further damage; such actions will limit damage during outbreaks but will not change the conditions which led up to an outbreak. This can only be achieved through long-term silvicultural manipulations. Short-term direct control does serve a purpose, however, in lessening immediate impact and protecting valuable resources.



Direct control of bark beetles is most appropriate when the infestations are localized or just beginning. The best combinations of treatments must be used.

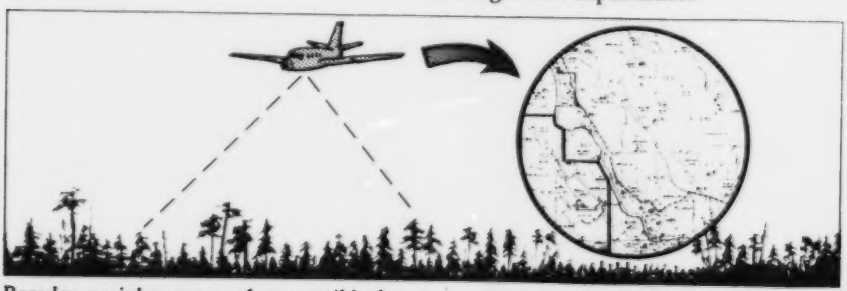
It is most effective when directed against small and medium-sized infestations where available resources can be expected to have a significant impact. Treatment of new infestations before they become unmanageable is the key to success and is dependent on a good detection program.

The foliage of trees killed by bark beetles (especially that of pine trees) turns red within one year – quite often the first sign that an infestation is beginning. Since this is very visible from the air, annual aerial surveys may be used to find infestations at an early age. These surveys can be directed to areas where there are extensive stands of susceptible trees, or to areas that have a history of beetle-related problems. If these surveys are carried out consistently, new spot infestations can be eliminated as soon as they are found.

Treatments that are effective in dealing with infestations of bark beetles include:

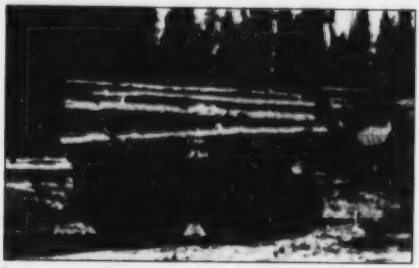
- sanitation logging
- single tree treatments
- the use of trap trees to control spruce beetle and Douglas-fir beetle

Good aerial and ground detection methods make all treatments much more effective and are a prerequisite in a beetle management program. Detection is the key to ensuring prompt action being taken on new spots before they expand beyond management capabilities.



Regular aerial surveys of susceptible forests are necessary to detect and map new beetle infestations.

Sanitation logging is by far the most efficient way of dealing with bark beetles. When infestations are identified, ground surveys provide information on the extent of attack within a stand. Logging can then be directed into those stands with a large number of infested trees, removing them. Subsequent levels of beetle-attacked trees in the area can then be dealt with either through further planned logging efforts or single-tree treatment.



Logging infested stands is the most efficient method of dealing with infested forests.

Single-tree treatment of individual infested trees, or small patches of infested trees, is suitable to clean up residual beetles after logging. Single tree treatments are also applicable to treating new small infestations to protect previously unaffected areas.

The most common form of single tree treatment in forestry operations is to cut down infested trees and burn them, killing beetles under the bark and reducing the number of nearby trees likely to be attacked. Such programs are labour-intensive and must be very thorough to be effective. They must also be continued for several years to ensure that beetle populations remain low. An area can be protected in this fashion for a period of years while access is being developed which will facilitate the application of more long-term solutions.

Of special interest to landowners or park managers is the possibility of protecting selected high-value trees from the beetle. These trees can be protected by applying insecticide sprays to the bark before the beetles attack. The spray will kill arriving beetles and prevent the trees from being overcome. Although effective, this type of treatment is also labour intensive. It is not practical to protect large commercially valuable stands of timber using insecticide treatments.

Piling and burning infested trees during the fall and winter is effective for treating small patches of attacked trees.

Applying insecticides to the stems of healthy trees can protect them from beetle attack.

Trap Trees can be used to reduce losses from spruce and Douglas-fir beetles. These prefer to attack windthrown trees or other downed

material. This aspect of their behaviour can be taken advantage of to manage and prevent outbreaks. A trap tree program, for example, can be implemented where spruce beetles are active. A suitable number of susceptible spruce trees can be felled in convenient locations to attract and absorb flying beetles. The beetles will infest the trap trees rather than the standing crop trees. The trap trees – with the beetles – can be removed and processed, or treated to kill the beetles.

If enough trap trees are used, stands are effectively protected. This approach can be incorporated into normal logging schedules, preventing the build-up of beetle populations.

All of the above methods – sanitation logging, single tree treatment, trap trees and others are most effective when applied to small infestations. Huge outbreaks covering thousands of hectares usually cannot be effectively managed. Insufficient numbers of beetles are killed to make any significant difference to the course of the infestation. Once this situation occurs, the only option is to salvage log the dead stands quickly before the trees become valueless. **A comprehensive detection program is essential to locate infestations before they get out of hand.**

Trap trees are purposely felled, susceptible trees that will attract spruce and Douglas fir beetles. These traps must be removed or treated to kill the beetles under the bark after they become infested.

What are we doing now?

The various long and short-term management strategies discussed above are all being used by the Ministry of Forests and Lands and by British Columbia's forest companies. Both government and private industry recognize the continued threat posed by outbreaks of bark beetles and are implementing programs to address the issue:

- **Comprehensive aerial and ground surveys** are carried out every year to find pockets of infestation which are then managed through harvesting or by other means of direct control.

Building roads provides access to infested and high risk forests so that appropriate treatments can be applied.

- **Road building** has been accelerated to provide access into threatened areas. This network of roads will provide access into some drainages before they become heavily infested, allowing harvesting of lightly infested stands and stands at risk. This access will allow modifications to be made to the structure of the forest, reducing the chance of future infestations. Age class and species mosaics can also be established, and when future infestations do arise, they can be controlled rapidly.
- **Survey and logging capabilities** in many parts of British Columbia are directed toward reducing the impact of bark beetles. Levels of harvest have been increased in areas with extensive infestations. Logging is being directed as much as possible into areas of infestation to sanitize stands and drainages before they are devastated.
- **Single-tree treatment programs** are also in place at the leading edge of infestations where eradication of small pockets of trees limit the spread of the beetle. Single tree disposals allow time to construct roads to remove susceptible stands. Such programs are also used to complement logging efforts to aid in complete sanitation. Direct tree treatments are employed to protect parks and other aesthetic areas where timber is not the primary reason for management.

Bark beetle management programs are extensive and expensive. For example, between 1983 and 1986, more than 300 kilometers of road were constructed or upgraded and over 75,000 infested trees were destroyed. Over $20 million has been spent on these and other bark beetle related activities during this period. The programs will be continued, protecting additional large areas of pine and spruce.

Beetle management programs require good planning and co-ordinated effort from all concerned.

Looking to the Future

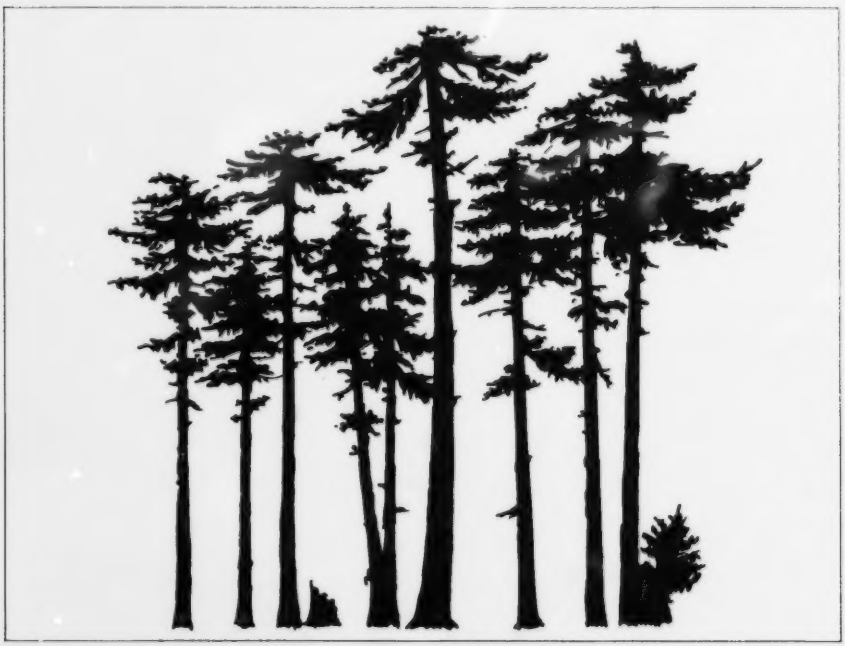
Bark beetles will always be a part of the forest ecosystem. These insects have evolved with the trees upon which they feed, and perform a necessary function in the natural cycle of the forest.

A balance must be struck between society – and its continuing need for forest products – and nature. While bark beetle infestations will continue to occur occasionally, management efforts can reduce their impact on the forest resource.

The long-term solutions discussed in this booklet are being implemented as levels of forest management are increased in British Columbia. In those areas with a history of chronic beetle problems, new managed stands will be established, thus reducing the number of trees killed, if and when a beetle outbreak occurs. Short-term programs will also be undertaken to limit the damage caused by any beetle infestations that arise.

Foresters have been taught a lesson by the bark beetle outbreaks of the 1970's and '80's. They have learned that the potential devastation that these insects represent cannot be ignored. Strategies for dealing with future bark beetle outbreaks are being incorporated into future management plans now.

The ultimate objective of pest management – and forest management in general – is to preserve and protect the forest resource – a resource which will continue to be the most valuable in the province. The control of bark beetles will continue to be a key component in an overall management strategy.



Good forest management will reduce further losses to bark beetles.

Common and Scientific Names

	Common Name	Scientific Name
Insects:	Mountain pine beetle	*Dendroctonus ponderosae*
	Spruce beetle	*Dendroctonus rufipennis*
	Douglas-fir beetle	*Dendroctonus pseudotsugae*
	Western pine beetle	*Dendroctonus brevicomis*
	Balsam bark beetle	*Dryocoetes confusus*
	Douglas-fir tussock moth	*Orgyia pseudotsugata*
	Western spruce budworm	*Choristeneura occidentalis*
Trees:	Lodgepole pine	*Pinus contorta latifolia*
	Ponderosa pine	*Pinus ponderosae*
	Engelmann spruce	*Picea engelmannii*
	White spruce	*Picea glauca*
	Douglas-fir	*Pseudotsugae menziesii*
	Subalpine fir	*Abies lasiocarpa*

Research Supports the Management Effort — Research scientists working with universities and the Canadian Forestry Service continue to study bark beetle biology and behaviour. These studies often produce information which improves management efforts and, therefore, continuing research in this area is a much needed component in the overall effort to deal with bark beetles. Some research benefits so far:

Semiochemicals are substances produced by bark beetles that affect beetle behaviour. One type of these, aggregation semiochemicals called pheromones, attracts beetles to potential host trees and plays a major role in inducing successful mass-attack of a tree.

Researchers (mainly at Simon Fraser University) have identified and synthesized these compounds successfully and they are now available commercially. These baits, or lures, are used in beetle management programs to "hold" beetle populations in known areas until treatment can be affected. This greatly simplifies the task of finding the beetles and so makes treatment more effective at lower cost.

Other studies conducted by Canadian Forestry Service scientists have provided several options for direct control treatments other than falling and burning infested trees. These include the use of systemic and topically applied insecticides. Further, research is continuing on the ways that beetles disperse throughout a forest; the results of these studies will be valuable in developing harvesting and other treatment strategies. Hazard rating systems are also being assessed so that levels of damage can be predicted — this is of great use in planning management approaches.

There is a good deal of cooperation between the various agencies involved with bark beetles. Such cooperation may be in the form of sharing of research and operational information or in jointly carrying out control projects. These coooperating agencies include: B.C. Forest Service, Alberta Forest Service, Federal and Provincial Parks Branches, Canadian Forestry Service, and the United States Forest Service. This cooperation provides a broad-based support to management efforts in British Columbia.

Selected Additional Reading

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Pest Management Publications

Other Booklets in this Series —

— The Real Enemy — Major Forest Pests of British Columbia
— Pesticides in Forest and Range Management
— Forest Diseases and Forest Management

Available from:

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Also available at the above address are PesTopics — a series of one to two page leaflets discussing various facets of forest pest management.

Other Publications Available —

Pest Leaflets —
A series of leaflets produced by the Canadian Forestry Service describing individual pests — both insects and diseases. These are available from:

Information Officer
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Canadian Forestry Service
506 W. Burnside Road
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